Federal Aviation Administration – Regulations and Policies
Aviation Rulemaking Advisory Committee

Transport Airplane and Engine Issue Area
Powerplant Installation Harmonization Working Group

Task 6 – Prohibition of Inflight Operation for Turbo propeller Reversing System

Task Assignment

[Federal Register: September 23, 1998 (Volume 63, Number 184)]
[Notices]
[Page 50954-50955]
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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Aviation Rulemaking Advisory Committee; Transport Airplane and Engine Issues--New Tasks

AGENCY: Federal Aviation Administration (**FAA**), DOT.

ACTION: Notice of new task assignments for the Aviation Rulemaking Advisory Committee (ARAC).

SUMMARY: Notice is given of new tasks assigned to and accepted by the Aviation Rulemaking Advisory Committee (ARAC). This notice informs the public of the activities of ARAC.

FOR FURTHER INFORMATION CONTACT: Stewart R. Miller, Transport Standards Staff (ANM-110), Federal Aviation Administration, 1601 Lind Avenue, SW., Renton, WA 98055-4056; phone (425) 227-1255; fax (425) 227-1320.

SUPPLEMENTARY INFORMATION:

Background

The **FAA** has established an Aviation Rulemaking Advisory Committee to provide advice and recommendations to the **FAA** Administrator, through the Associate Administrator for Regulation and Certification, on the full range of the **FAA**'s rulemaking activities with respect to aviation-related issues. This includes obtaining advice and recommendations on the **FAA**'s commitment to harmonize its Federal Aviation Regulations (FAR) and practices with its trading partners in Europe and Canada.

One area ARAC deals with is Transport Airplane and Engine Issues. These issues involve the airworthiness standards for transport category airplanes and engines in 14 CFR parts 25, 33, and 35 and parallel provisions in 14 CFR parts 121 and 135.

The Tasks

This notice is to inform the public that the **FAA** has asked ARAC to provide advice and recommendation on the following harmonization tasks:

Task 5: Power Plant Fire Mitigation Requirements

Specific Tasks--Phase I
1. Rule Harmonization
(a) JAR 25.1183 has a (c) paragraph that adds the requirement for

components to be fireproof where, if damaged, fire could spread or essential services could be adversely affected.

(b) FAR/JAR 25.1187, 25.1189(a) and 25.1193(c) are considered equivalent--no harmonization is required.

2. Advisory Material (AC/AMJ) Harmonization

(a) FAR 25.1187--Drainage and Ventilation of Fire Zones. **FAA** regulation requires the provisions for flammable fluid drainage, including the drainage path and drainage capacity, be demonstrated to be effective under anticipated conditions. Draft AC 25.1187, published for comments, describes the methodology to be used. **FAA** and JAA agreement on an acceptable means of demonstrating compliance is required. The Advisory Material to be developed should provide guidance on an acceptable means of demonstrating compliance for ``drainage of flammable fluids''.

(b) FAR 25.1189(a)--Shutoff Means. This paragraph requires shutoff valves to prevent a hazardous quantity of flammable fluid entering a fire zone following detection of a fire. The central issue to be resolved is associated with **FAA**/JAA agreement of the definition of ``hazardous quantity'' of flammable fluid. The working group should provide guidance to the **FAA** and JAA to define what is considered a ``Hazardous Quantity of Flammable Fluid'' when showing compliance to this regulation.

(c) FAR 25.1193(c)--Cowling and Nacelle Skin. **FAA** requires the nacelle be fireproof for 360 degrees, unless aerodynamic testing shows that fire exiting the nacelle poses no additional hazards to the airframe. JAA reportedly accepts 90 degrees (45 degrees from pylon centerline) without additional testing. JAA NPA proposes to provide guidance (JAA PNPA 25E-266). **FAA** and JAA should document current practices for use by Task Group consideration towards development of harmonized guidance regarding this subject. The Guidance Material to be developed should provide guidance on an acceptable means of demonstrating that the extent of fire proof cowling assures ``no additional hazard to the airframe'' for all types of transport category airplane engine installations.

The **FAA** expects ARAC to submit its recommendation(s) resulting from Phase I by November 30, 2000.

Specific Tasks--Phase II

1. Rule Harmonization

(a) Harmonize the definitions of the terms ``fire resistant'' and ``fire proof'' in FAR 1 and JAR 1.

2. Advisory Material (AC/AMJ) Harmonization

(a) Draft additional advisory material for 25.903(d)(1) related to minimizing the hazard associated with engine case burnthrough.

(b) Validate and harmonize the Fire Test Guidance Material in Paragraph 8 of AC 20-135 (may be transferred to be included in burnthrough advisory material).

(c) Validate and Harmonize the FAR/JAR Advisory Material for Engine Case Burnthrough and/or Related Engine Fire Test Guidance material such as an ISO standard.

The **FAA** expects ARAC to submit its recommendation(s) resulting from Phase II by April 1, 2001.

Task 6: Prohibition of Inflight Operation for Turbopropeller Reversing System and Turbojet Thrust Reversing System Intended for Ground Use Only

Recommend harmonized changes to FAR/JAR 25.1155 which would require

a means to prevent the flight crew of turbine powered airplanes from inadvertently or intentionally placing the propellers into beta, deploying the thrust reverser while inflight, or otherwise commanding reverse thrust, unless the airplane has been certified for such operation. In addition to the harmonized rule recommendation, harmonized advisory material may also need to be developed in order to further standardize compliance with the recommended rule.

The **FAA** expects ARAC to submit its recommendation(s) resulting from this task by July 31, 2001.

[[Page 50955]]

Task 7: Powerplant Inflight Restarting

Review FAR 25.903(e) and corresponding JAR requirement related to inflight restarting and generate an amended harmonized requirement that provides a minimum engine restart capability within the airplane operating envelope following loss of all engine thrust. In addition, provide harmonized advisory material that defines the acceptable methods of compliance to the amended regulations. Both of these tasks should take into account and address:

1. Review of the service history.
2. Review of inherent starting capability of the engines at the time the original 25.903(e) rule was promulgated.
3. Alternative design means for restarting main engines.

The **FAA** expects ARAC to submit its recommendation(s) resulting from this task by July 31, 2001.

The **FAA** requests that ARAC draft appropriate regulatory documents with supporting economic and other required analyses, and any other related guidance material or collateral documents to support its recommendations. If the resulting recommendation(s) are one or more notices of proposed rulemaking (NPRM) published by the **FAA**, the **FAA** may ask ARAC to recommend disposition of any substantive comments the **FAA** receives.

Working Group Activity

The Powerplant Installation Harmonization Working Group is expected to comply with the procedures adopted by ARAC. As part of the procedures, the working group is expected to:

1. Recommend a work plan for completion of the tasks, including the rationale supporting such a plan, for consideration at the meeting of ARAC to consider transport airplane and engine issues held following publication of this notice.
2. Give a detailed conceptual presentation of the proposed recommendations, prior to proceeding with the work stated in item 3 below.
3. Draft appropriate regulatory documents with supporting economic and other required analyses, and/or any other related guidance material or collateral documents the working group determines to be appropriate; or, if new or revised requirements or compliance methods are not recommended, a draft report stating the rationale for not making such recommendations. If the resulting recommendation is one or more notices of proposed rulemaking (NPRM) published by the **FAA**, the **FAA** may ask ARAC to recommend disposition of any substantive comments the **FAA** receives.
4. Provide a status report at each meeting of ARAC held to consider

transport airplane and engine issues.

The Secretary of Transportation has determined that the formation and use of ARAC are necessary and in the public interest in connection with the performance of duties imposed on the **FAA** by law.

Meetings of ARAC will be open to the public. Meetings of the Powerplant Installation Harmonization Working Group will not be open to the public, except to the extent that individuals with an interest and expertise are selected to participate. No public announcement of working group meetings will be made.

Issued in Washington, DC, on September 17, 1998.

Joseph A. Hawkins,

Executive Director, Aviation Rulemaking Advisory Committee.

[FR Doc. 98-25469 Filed 9-22-98; 8:45 am]

BILLING CODE 4910-13-M

Recommendation Letter

400 Main Street
East Hartford, Connecticut 06108

Pratt & Whitney
A United Technologies Company

June 1, 2000

Department of Transportation
Federal Aviation Administration
800 Independence Avenue, SW
Washington, DC 20591

Attention: Mr. Anthony Fazio, ARM-1

Subject: ARAC Report Submittal

Reference: ARAC Tasking, Federal Register, November 19, 1999

Dear Tony,

In accordance with the reference tasking, the ARAC Transport Airplane and Engine Issues Group is pleased to submit the following "Fast Track" report as an ARAC recommendation.

25.1155 Reverse thrust and propeller pitch settings below the flight regime.

This report has been prepared by the Powerplant Installation Harmonization Working Group of TAEIG.

TASK # 6

Sincerely yours,

Craig R. Bolt

C. R. Bolt
Assistant Chair, TAEIG

Copy: Kris Carpenter, FAA - NWR
*Effie Upshaw, FAA - ARM-209
*Frederick A. Lewis-Smith - Boeing

*letter only

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ANM-98-479-A

Acknowledgement Letter

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CONCURRENCES	
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INITIALS/SIGNATURE	eu
DATE	7-20-00
ROUTING SYMBOL	ANM-114
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JUL 31 2000

Mr. Craig Bolt
Assistant Chair, Transport Airplanes
and Engines Issues Group
400 Main Street
East Hartford, CT 06108

Dear Mr. Bolt:

This letter acknowledges receipt of two letters dated June 1 transmitting working group reports on behalf of the Aviation Rulemaking Advisory Committee (ARAC) on Transport Airplane and Engine Issues (TAE). The following reports were submitted:

Task Nos.	Description of Recommendation	Working Group
6	Fast track report addressing 25.1155, prohibition of inflight operation for turbopropeller reversing system and turbojet thrust reversing system intended for ground use only.	PPIHWG
9	Disposition of comments addressing Notice No. 99.09 proposed Advisory Circular (AC) 25.723-1. The proposed rulemaking and advisory circular discuss revisions to the landing gear shock absorption test requirements for transport category airplanes.	LDHWG ANM-98-182-A
11	Disposition of comments addressing Proposed AC 25.491-1, "Taxi, Takeoff, and Landing Roll Design Loads."	LDHWG ANM-94-461-A

The above listed reports will be forwarded to the Transport Airplane Directorate for review. The Federal Aviation Administration's progress will be reported at the TAE meetings.

I would like to thank the ARAC, particularly those members associated with TAE for its cooperation in using the fast track process and completing the working group reports in a timely manner.

Sincerely,

ORGINIAL SIGNED BY
ANTHONY F. FAZIO

Tony F. Fazio
Director, Office of Rulemaking

ARM-209:EUpshaw:fs:6/27/00:PCDOCS #12756v1
cc: ARM-1/20/200/209; APO-300/320, ANM-114
File #1340.12

File #ANM-98-182-A (landing gear shock absorption test requirements) and ANM-94-461-A (Taxi, takeoff, and landing roll design loads)

Recommendation

PPIHWG, Harmonization Proposal for FAR/JAR-25.1155
Reverse thrust and propeller pitch settings below the flight regime

1 - What is underlying safety issue addressed by the FAR/JAR? [Explain the underlying safety rationale for the requirement. Why does the requirement exist?]

This requirement is intended to make sure that flight crew are always required to perform a separate and distinct operation, whenever they displace the reverse thrust control from the forward thrust regime and the control for propeller pitch below the flight regime. For the majority of aircraft, this action, if performed in flight, could lead to a Hazardous or Catastrophic situation. Even for aircraft, which are approved for in-flight operation of the thrust reverser under FAR 25.933(a)(2), the provision introduced by §25.1155 enables the pilot to be aware, when the selection from forward to reverse thrust is made.

2 - What are the current FAR and JAR standards? [Reproduce the FAR and JAR rules text as indicated below.]

FAR 25.1155 and JAR 25.1155 standards are shown below:

> **§25.1155 Reverse thrust and propeller pitch settings below the flight regime.**
> Each control for reverse thrust and for propeller pitch settings below the flight regime must have means to prevent its inadvertent operation. The means must have a positive lock or stop at the flight idle position and must require a separate and distinct operation by the crew to displace the control from the flight regime (forward thrust regime for turbojet powered airplanes).

> **JAR 25.1155 Reverse thrust and propeller pitch settings below the flight regime**
> Each control for reverse thrust and for propeller pitch settings below the flight regime must have means to prevent its inadvertent operation. The means must have a positive lock or stop at the flight idle position and must require a separate and distinct operation by the crew to displace the control from the flight regime (forward thrust engine regime for turbo-jet powered aeroplanes).

3 - What are the differences in the standards and what do these differences result in?: [Explain the differences in the standards, and what these differences result in relative to (as applicable) design features/capability, safety margins, cost, stringency, etc.]

The regulations are identical. There is no existing advisory material on this subject.

4 - What, if any, are the differences in the means of compliance? [Provide a brief explanation of any differences in the compliance criteria or methodology, including any differences in either criteria, methodology, or application that result in a difference in stringency between the standards.]

There is no documented variation in the interpretation of the existing requirement. However there have been two influences, which have shown that the existing §25.1155 requirement is not sufficient to control the potential hazards.

(i) There has been a number of accidents to turbo-propeller powered aircraft, where the instigating action has been a movement of the propeller pitch control to a position below the flight regime, when the aircraft was in flight. In these cases, the resulting effects on the engine/propeller

speed and/or the controllability of the aircraft, were sufficient to cause an accident. The accidents were found to have been caused by both deliberate and unintentional movements of the propeller pitch control to a position below the flight regime. Consequently the FAA have been implementing a policy, through Issue Papers, which requires turbo-propeller powered aircraft to incorporate a means to prevent any such movement of the propeller pitch control, when the aircraft is in flight.

(ii) During the work of the ARAC §25.933 Task Group, a Minority Position was raised on some thrust reverser design issues, including 'Prevention of Selection'. The Minority Position maintained that:

- there should be a requirement for the thrust reverser control to incorporate a means to prevent selection of reverse in flight.
- such a means to prevent selection of reverse thrust in flight is current design practice.
- this means would complement thrust reverser designs, which have Extremely Improbable in-flight deployment probability.
- safety benefits would also be realized for those aircraft, which were Certificated to be 'Controllable', following a thrust reverser deployment, by minimizing these events.
- increasing awareness of human factors issues is starting to influence aircraft design, by trying to eliminate those pilot actions, which could cause hazards.

5 – What is the proposed action? [Is the proposed action to harmonize on one of the two standards, a mixture of the two standards, propose a new standard, or to take some other action? Explain what action is being proposed (not the regulatory text, but the underlying rationale) and why that direction was chosen.]

As a result of the above two influences, Terms of Reference for an new ARAC Task were prepared by the Powerplant Installation Harmonization Working Group (PPIHWG) for a revision to §25.1155 to require: " ...means to prevent the flight crew of turbopropeller powered airplanes from inadvertently or intentionally placing the power lever below flight idle (beta operation) while in-flight, unless the airplane has been certified for in-flight beta operation. ... Discussion resulting from the work of the Powerplant Installation Harmonization Working Group's FAR/JAR 25.933 Task Team activity concluded that a similar command inhibition requirement would be prudent for turbojet thrust reverser systems which are intended only for use on the ground."

The PPIHWG set up the §25.1155 Task Group to work on the identified Task and they have prepared new Rule and Advisory Material (See Section 6 below).

6 - What should the harmonized standard be? [Insert the proposed text of the harmonized standard here]

The §25.1155 Task Group propose the following revision to the §25.1155 Rule.

§25.1155 Propeller pitch settings below the flight regime and reverse thrust .

Each control for selecting propeller pitch settings below the flight regime (reverse thrust for turbo-jet powered airplanes) must have:

(a) a positive lock or stop which requires a separate and distinct operation by the crew to displace the control from the flight regime (forward thrust regime for turbo-jet powered airplanes); it must only be possible to make this separate and distinct operation once the control has reached the Flight Idle position

(b) a means to prevent both inadvertent and intentional selection or activation of propeller pitch settings below the flight regime (thrust reversal for turbo-jet powered airplanes) when out of the

approved in-flight operating envelope for that function; and override of that means shall be prohibited;

(c) a reliability, such that the loss of the means required by section (b) above shall be remote;

(d) a caution to the crew when the means required by section (b) above is lost;

(e) a caution to the crew when a cockpit control is displaced from the flight regime (forward thrust regime for turbo-jet powered airplanes) into a position to select propeller pitch settings below the flight regime (reverse thrust for turbo-jet powered airplanes) outside the approved in-flight operating envelope. This caution need not be provided if the means required by section (b) is a mechanical baulk preventing movement of the control.

Even though not included in the rule, it is the intent that the caution required by (d) above need not be required if the loss of the means is extremely remote. The intent is that this should be addressed in the NPRM.

7 - How does this proposed standard address the underlying safety issue (identified under #1)? [Explain how the proposed standard ensures that the underlying safety issue is taken care of.]

The revised rule retains the intent of the existing rule and adds a requirement for additional means for preventing the flight crew from making a selection, which could hazard the aircraft.

8 - Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety? Explain. [Explain how each element of the proposed change to the standards affects the level of safety relative to the current FAR. It is possible that some portions of the proposal may reduce the level of safety even though the proposal as a whole may increase the level of safety.]

The new rule improves the required level of safety for turbo-propeller powered aircraft, by eliminating the possibility of one flight crew selection error, which can lead to a hazardous situation in flight. Although, in principle, the provision of a system to meet the revised rule could reduce the probability that the required low pitch is available for the landing rollout, there has been no suggestion that this will reduce safety. With careful design, the safety objectives for both the flight and ground operational phases should be capable of being met.

For turbo-jet powered aircraft, the new rule also improves the required level of safety, by eliminating the possibility of a flight crew selection error, which can lead to a hazardous situation in flight.

Considerable discussion was given to an override system, where the flight crew could deactivate the inhibiting system required by 25.1155(b) outside the approved in-flight operating envelope for that function. The concern was whether the requirement for the inhibiting system would have a significant effect on the frequency of not having reverse thrust available on landing rollout. It is this group's opinion that a well designed system would not have this adverse effect, and therefore, the override system would be of little benefit. Moreover, an override system allows the flight crew to defeat the very safeguards included in the rule. For these reasons such a function is considered undesirable.

9 - Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain. [Since industry practice may be different than what is required by the FAR (e.g., general industry practice may be more restrictive), explain how each element of the proposed change to the standards affects the level of safety relative to

current industry practice. Explain whether current industry practice is in compliance with the proposed standard.]

Following the application of the FAA Turbo-propeller Reversing System Issue Paper, many of the turbo-propeller powered aircraft Certificated in the past 10 years, have been required to fit a means to prevent selection of propeller pitch settings below the flight regime. For these aircraft, the required level of safety will be maintained.

For turbo-jet powered aircraft, the new rule confirms that the existing design practice of providing a means to prevent selection of reverse thrust in the air, is the required minimum standard.

10 - What other options have been considered and why were they not selected?: [Explain what other options were considered, and why they were not selected (e.g., cost/benefit, unacceptable decrease in the level of safety, lack of consensus, etc.]

No other materially different options have been identified or discussed

11 - Who would be affected by the proposed change? [Identify the parties that would be materially affected by the rule change – airplane manufacturers, airplane operators, etc.]

Applicants for new, amended or supplemental Type Certificates, which typically include manufacturers and modifiers.

12 - To ensure harmonization, what current advisory material (e.g., ACJ, AMJ, AC, policy letters) needs to be included in the rule text or preamble? [Does the existing advisory material include substantive requirements that should be contained in the regulation? This may occur because the regulation itself is vague, or if the advisory material is interpreted as providing the only acceptable means of compliance.]

The development of the new Rule and its Advisory Material has been carried out with the intention of retaining the proper division between the 'mandatory' element of rule-making and the 'advisory' element of AC/ACJ material. It is the Task Group's intention that the AC/ACJ material will be one means but not the only means of showing compliance.

13 - Is existing FAA advisory material adequate? If not, what advisory material should be adopted? [Indicate whether the existing advisory material (if any) is adequate. If the current advisory material is not adequate, indicate whether the existing material should be revised, or new material provided. Also, either insert the text of the proposed advisory material here, or summarize the information it will contain, and indicate what form it will be in (e.g., Advisory Circular, policy, Order, etc.)]

New AC/ACJ material (attached below) has been prepared to advise aircraft manufacturers and suppliers about acceptable means of compliance. This advice relates to both the original part of the requirement, which specifies the need for a separate and distinct operation to displace the control from the flight regime and to the new part of the requirement, which specifies the new 'means to prevent selection'.

14 - How does the proposed standard compare to the current ICAO standard? [Indicate whether the proposed standard complies with or does not comply with the applicable ICAO standards (if any)]

ICAO Annex 8 does not specifically address the subject of reverse selection. However, this revised version of §25.1155 will assist in complying with ICAO Annex 8, Chapter 7:
"7.1.2 Compliance with engine and propeller limitations
The powerplant installation shall be so designed that the engines and propellers (if applicable) are capable of being used in the anticipated operating conditions. In conditions established in the aeroplane flight manual the aeroplane shall be capable of operating without exceeding the limitations established for the engines and propellers in accordance with Chapters 5, 6 and 7."

Extract from ICAO Chapter 7.

15 - Does the proposed standard affect other HWGs? [Indicate whether the proposed standard should be reviewed by other harmonization working groups and why.]

There is no direct effect on other HWGs, but as this proposal affects the operation of flight deck controls and displays, this proposal will be of interest to the Flight Test Harmonization Working Group.

16 - What is the cost impact of complying with the proposed standard? [Is the overall cost impact likely to be significant, and will the costs be higher or lower? Include any cost savings that would result from complying with one harmonized rule instead of the two existing standards. Explain what items affect the cost of complying with the proposed standard relative to the cost of complying with the current standard.]

There will be an increased, but likely not significant, cost in airplane development.

17 - Does the HWG want to review the draft NPRM at "Phase 4" prior to publication in the Federal Register?

Yes.

18 – In light of the information provided in this report, does the HWG consider that the "Fast Track" process is appropriate for this rulemaking project, or is the project too complex or controversial for the Fast Track Process. Explain. [A negative answer to this question will prompt the FAA to pull the project out of the Fast Track process and forward the issues to the FAA's Rulemaking Management Council for consideration as a "significant" project.]

The §25.1155 Task Group consider that they have completed the task, as identified in the Terms of Reference. In preparing this rule proposal, account has been taken of the various thoughts and opinions expressed within the Task Group, about the benefits and consequences of its adoption. The completion of this harmonization task is appropriate for the fast track process and should be adopted.

U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Propeller pitch settings below the flight regime and reverse thrust.	Date: 04/18/00 (DRAFT) Initiated By: ANM-112	AC No: 25.1155X Change: Draft

1. PURPOSE. This advisory circular provides guidance for demonstrating compliance with the certification requirement relating to controls which regulate reverse thrust or propeller pitch settings below the flight regime on transport category airplanes. The Federal Aviation Administration will consider other methods of demonstrating compliance that an applicant may elect to present. This material is neither mandatory nor regulatory in nature and does not constitute a regulation.

2. RELATED DOCUMENTS.

a. Federal Aviation Regulations. Sections which prescribe requirements for the design, substantiation, and certification relating to the control of reverse thrust and propeller pitch settings below the flight regime of transport category airplanes include:

§25.777	Cockpit Controls.
§25.779	Motion and effect of cockpit controls
§25.781	Cockpit control knob shape
§25.901	Installation
§25.903	Engines
§25.933	Reversing systems
§25.1141	Powerplant controls: General
§25.1143	Engine controls
§25.1149	Propeller speed and pitch controls
§25.1155	Reverse thrust and propeller pitch settings below the flight regime
§25.1305	Powerplant instruments
§25.1309	Equipment, systems, and installations.
§25.1322	Warning, caution, and advisory lights
§25.1337	Powerplant instruments

b. Advisory Circulars (AC). The advisory circulars listed below may be obtained from the U.S. Department of Transportation, Subsequent Distribution Office, SVC-121.23, Ardmore East Business Center, 3341 Q 75th Avenue, Landover, MD 20785.

AC 25-901X	Safety Assessment of Powerplant Installations
AC 25-933X	Unwanted In-flight Thrust Reversal of Turbojet Thrust Reversers
AC25-1309XX	System Design and Analysis

3. APPLICABILITY.

The basic provisions of 25.1155 require that the control for selecting reverse thrust (propeller pitch settings below the flight regime) have a positive lock or stop at the flight idle position as well as separate and distinct operation by the flight crew to displace the control from the in-flight regime. These basic provisions are applicable to all transport category airplanes. The specific provisions of §25.1155 are applicable to the control system protecting against the intentional or the inadvertent in-flight selection of the thrust reverser for turbojet powered airplanes or propeller operation at pitch settings below the flight regime for turboprop powered airplanes. Further, the referenced requirement would not be applicable to a turbojet powered airplane whose reverser was certified for in-flight use or to a turbo-propeller powered airplane whose propellers were certified for pitch settings below the normal in-flight operating regime.

In addition to the 25.1155 applicability limitations noted above, the intentional selection provisions should not be interpreted to include a pilot who knowingly gains in-flight access to the prohibited engine control regime by :
a) disabling a protective control system (i.e. throttle balk or warning) by pulling circuit breaker, or
b) ignoring a clearly annunciated protective control system failure warning or caution message.

4. BACKGROUND.

a. Requirement History:

The requirements to guard against inadvertent operation of both cockpit mounted propeller and turbojet reverse control lever(s) date back to CAR 4b (4b.474a). When part 25 was codified in 1965, only the turbojet reverse section of the subject requirement was retained as FAR §25.1155. In 1967, Amendment 25-11 broadened §25.1155 to once again include protection against inadvertent in-flight operation of thrust reversers and propeller pitch settings below the flight regime. This Amendment required the cockpit propeller control to incorporate positive locks or stops at the flight idle position, and further specified that the control means must require a separate and distinct operation by the crew, in order to displace the propeller control from the flight regime.

b. Operational Experience - Turbo-propeller powered Airplanes:

In-service experience during the late 1980s and 1990s of some turbo-propeller powered transport category airplanes, has shown that intentional or inadvertent in-flight operation of the propeller control systems below flight idle has produced two types of hazardous, and in some cases, catastrophic conditions:

(i) Permanent engine damage and total loss of thrust on all engines when the propellers that were operating below the flight regime drove the engines to over-speed, and;
(ii) Loss of airplane control because at least one propeller operated below the flight regime during flight creating asymmetric control conditions.

As a result of this unsatisfactory service experience, in-flight beta lockout systems were retroactively required (via Airworthiness Directives) on several transport category turboprop airplanes. These beta lock-out systems were required only after it was determined that increased crew training, installation of cockpit placards warning crews not to use beta in flight, and stronger wording in AFM warnings

and limitations did not preclude additional in-flight beta events.

In addition to the continued airworthiness issues noted above the FAA also recognized the need to update the FAR requirement to require some form. Until the rule changes noted above are complete, the FAA is using the no unsafe feature or characteristic provisions of 21.21(b)(2) to require installation of beta lockout systems on new transport category turbo-propeller powered airplanes.

Intentional selection of beta mode/reverse in flight for rapid aircraft deceleration was not specifically addressed by this regulation. Also, FAR 25.933(b) had been interpreted as not requiring, for turbo-propeller aircraft, an interlock or other automatic device to prohibit movement of the power lever by the flight crew below the flight idle stop when the aircraft is in flight.

Consequently, initial FAA certification of transport category turbo-propeller aircraft has not required an in-flight beta lockout device to prevent intentional selection of the beta mode/reverse in flight.

As a result of these incidents and accidents, Amendment 25-xx was published in 200X, which required that a means to prevent both inadvertent and intentional in-flight selection of reverse thrust or propeller pitch settings below the regime, unless of course the airplane was certified for such operation.

Typical beta lockout systems currently use wheel spin-up, squat switch activation, gear-up switch activation, or combinations of these. Certain airplanes, especially those with low wings and without ground spoilers, have a tendency to float during landing. In the case of these airplanes, the application of beta may be delayed on a wet runway because, while the airplane is floating, the ground logic or the wheel spin-up may not activate immediately.

Landing performance of turbo-propeller-powered airplanes is based on ground idle availability, which is part of the beta range. Turbo-propeller-powered airplanes landing on field length-limited runways with delayed beta application present a potential hazard. Overruns are more likely to occur if operating under part 91 (un-factored field lengths); however, the risks are also present if operating under parts 121 or 135 (factored field lengths) on a wet runway. Paragraph (b) of the rule prohibits override, however, there are several acceptable methods that may be used to overcome the deficiencies of the squat switch or wheel spin-up logic alone, such as the use of a radar altimeter or multiple air/ground logic inputs.

c. Operational Experience - Turbo-jet (Turbo-fan) Powered Airplanes.

For turbojet (turbofan) thrust reversers, there has not been such a bad accident experience of pilot initiated thrust reverser deployment as for the turbo-propeller airplanes, but they have occurred. There has also been a number of reported cases, where the thrust reversers have been selected before touch down, in order to minimize the landing roll. In these cases, the provision of a weight-on-wheels (WOW) interlock as part of the thrust reverser design, prevented the deployment of the reverser. However, the basic concern about the need to avoid a reversing condition, outside any approved operating regime, is the same for a thrust reverser equipped aircraft, as it is for a propeller powered aircraft i.e. the prevention of Catastrophic failure conditions.

§25.933(a) and its AC / ACJ describe means by which the thrust reverser system can be shown to have sufficient system integrity, to meet the required Safety Objectives. If the reliability method of compliance with §25.933(a) is used, the probability of an unwanted reverser deployment in flight will be shown to be <1E-09. In this case, where very low probabilities of system failures are demonstrated,

it was considered to be inappropriate that a single event of pilot selection could cause the same effect, - a reverser deployment. Recognition that occurrences of thrust reverser selection in flight have occurred, reinforced by the growing perception that human factors need to be considered, has resulted in thrust reverser controls being considered equally. This approach ensures consistency in the application of §25.1155 to both turbo-prop and turbo-jet (turbo-fan) reversing systems.

The design objective sought by §25.1155 has been a common design practice for many turbo-jet (turbofan) thrust reverser designs. This rule establishes that a means to prevent crew selection or activation of reverse thrust or propeller pitch settings below the flight regime must be provided, as the minimum required standard.

d. Override Systems:

Historically, some turbo-propeller systems have been provided with an override capability, such that on landing, if the selection of pitch below flight idle is not successful - because of system failures or because signals used in the system may not have transitioned to the ground mode - the flight crew could select the override function to enable use of pitch below flight idle during ground operation. As mentioned above, many turbo-jet (turbofan) powered airplanes equipped with thrust reversers have utilized weight-on-wheels, or other air-ground logic, to prevent selection or activation of thrust reversers in flight. Generally, these systems have been capable of successful operation, despite not being equipped with any form of over-ride. It is the intention of the revised version of §25.1155 to prevent any selection or activation of propeller pitch below the flight regime or reverse thrust in flight. The provision of any override, which would allow selection or activation of propeller pitch below the flight regime or reverse thrust out the approved in flight envelope for that function would not comply with the §25.1155. The design of the system to show compliance with §25.1155 will need to take into account the Safety Objectives associated with the maintenance of the required landing performance.

5. DEFINITIONS.

5.a Approved in-flight operating envelope:
An area of the Normal Flight Envelope where a function has been accepted as suitable by the Authorities

5.b Catastrophic:
see AC 25.1309X

5.c Continued Safe Flight and Landing:
see AC 25.1309X

5.d Failure:
see AC 25.1309X

5.e Flight idle position:
the position of thrust/power lever corresponding to the minimum forward thrust, power or pitch setting authorized in flight

5.f Inadvertent:
action performed by the pilot who did not mean to do it

5.g In-flight:
that part of airplane operation beginning when the wheels are no longer in contact with the

ground during the takeoff and ending when the wheels again contact the ground during landing.

5.h Intentional:
action performed by the pilot who meant to do it

5.i Propeller pitch control system:
all those system components which enable the flight crew to command and control propeller pitch

5.j Remote:
see
AC 25.1309X

5.k Reverse control system:
all those system components which enable the flight crew to command and control the thrust reverser

5.l Separate and distinct:
more than or in addition to a continuation of motion required for movement and obvious to each member of the flight crew

5.m Thrust Reversal:
A movement of all or part of the thrust reverser from the forward thrust position to a position that spoils or redirects the engine airflow.

5.n Turbojet (or turbofan):
A gas turbine engine in which propulsive thrust is developed by the reaction of gases being directed through a nozzle.

5.o Turbo-propeller:
A gas turbine engine in which propulsive thrust is developed by the propeller

6. COMPLIANCE with §25.1155.

a) Cockpit controls

The cockpit controls mean the control devices used by the crew to select the reverse thrust or the propeller pitch below the flight regime. (See FAR/JAR 25.1141, 25.1143 and 25.1149)
Cockpit controls design must be adequate to permit the crew to perform the handling of the aircraft and to follow the procedures as per AFM, while mitigating crew errors.

b) Preventative means

Acceptable means to prevent intentional or inadvertent selection or activation of reverse thrust or propeller pitch below the flight regime' can be:
1) Devices to prevent movement of the cockpit control which prevents selection, or
2) Logic in the Thrust Reverser or Propeller Control which prevents activation.

c) Separate and distinct

To move cockpit controls from the Flight Idle position must require a separate and distinct operation of the control to pass from the Flight Idle position to positions approved only for ground operation.

The control must also have features to prevent inadvertent movement of the control through the Flight Idle position. It must only be possible to make this separate and distinct operation once the control has reached the Flight Idle position.

Separate and distinct is more than or in addition to a continuation of motion required for movement to the Flight Idle setting and must be obvious to the flight crew.

Examples of separate and distinct controls that have been used in previous designs are as follows:

i) Physically separate forward/reverse[below flight idle] control levers or mechanisms.

ii) Manually actuated latches located on or in the vicinity of the control that can not be actuated until Flight Idle.

iii) A required change in direction of operation of the control from that needed for movement to Flight Idle.

Examples of separate and distinct control operation, which would not be acceptable include:

i) a separate operation, which can be activated away from the Flight Idle position, so that movement of the control from forward thrust to below the flight regime or thrust reversal can be accomplished with a single action.

ii) any separate operation, where latches or equivalent devices can be pre-loaded by the pilot so that a single movement of the control, enables movement below flight idle.

iii) any control arrangement, where it can be ascertained that normal wear and tear could cause the separate and distinct action to be lost.

d) Cockpit indications

The overall indication requirements for Thrust Reverser Control System and Propeller Pitch Control System are given in the FAR/JAR 25.933, 25.1305(d)(2), 25.1309(c), 25.1322, and 25.1337(e) paragraphs and their associated AC/ACJs. The following text adds some specific guidance with respect to the requirements of paragraph 25.1155(d) and (e).

Sub-paragraphs "(d)" and "(e)" of the rule require crew cautions to be provided for two conditions:

"(d)" when the means 'to prevent both inadvertent and intentional selection of propeller pitch settings below the flight regime (thrust reversal for turbo-jet powered airplanes) when out of the approved in-flight operating envelope for that function' is lost. The purpose of this caution is to inform the flight crew that a fault has occurred to the propeller pitch control system or the thrust reverser control system, so that the protection means is no longer available and any movement of the control below the flight regime (forward thrust regime) may cause a low pitch/high drag condition or thrust reverser deployment. With this information, the flight crew will be able to take appropriate precautions, as advised by approved Manuals and reinforced by their training, to minimize the possibility of a hazardous condition. Without this caution, a fault in the protection means could allow an unsafe condition to occur, whereby any inadvertent or intentional movement of the control below the flight regime could cause a hazardous low pitch or reverse thrust condition.

"(e)" when the cockpit control is displaced from the flight regime (forward thrust for turbo-jet powered airplanes) into a position to select propeller pitch settings below the flight regime (thrust reversal for turbo-jet powered airplanes) and the airplane is outside the approved in-flight operating envelope for that function. On some anticipated system designs, the pilot will have the ability to move the cockpit control below the flight regime (into thrust reverse for turbo-jet powered airplanes) with no restriction, other than the 'separate and distinct operation' required by § 25.1155(a). For this type

of design, the means to prevent propeller pitch settings below the flight regime (reverse thrust for turbo-jet powered airplanes) when out of the approved in-flight operating envelope for that function will be a part of the propeller pitch control system or the thrust reverser system. Whilst there is no immediate hazard at that point, the control is not in the proper position for flight operations and the flight crew need to be made aware of that situation, so that they can take the appropriate action. In some of the accidents, where the control had been moved into the 'below flight ' regime, it was not clear whether this control movement had been inadvertent or intentional. Provision of this caution will give the crew a clear indication of any incorrect placement of the control however the control was positioned. For any design, where there is approval for selection of propeller pitch settings below the flight regime (reverse thrust for turbo-jet powered airplanes), there will be no need to provide this caution when the aircraft is in the approved in-flight operating envelope for that function. Also, as made clear in § 25.1155(e), there is no requirement to provide any caution for control movement, when on the ground.

e) Reliability considerations

The intention of § 25.1155(b) is for the aircraft design to include a means to prevent the flight crew selecting (or activating) propeller pitch settings below the flight regime or reverser deployment, when the aircraft is not in the approved in-flight operating envelope for that function. The introduction of the rule stems directly from a number of cases, where such a selection has caused accidents. Because of a large variability in the current perception of the future occurrence rate for this type of flight crew error, a target reliability level for the prevention means is included in the rule, see §25.1155(c). This level of reliability is expected to give a high degree of protection from the unwanted selection or activation of low propeller pitch or reverser deployment. The provision of the cautions should provide the necessary safeguard, on the few occasions when the prevention means fails. Additionally, this target safety level should not be inconsistent with the required availability of the reversing function for landing performance.
The safety assessment methods established by § 25.901(c) and §25.1309(b) are appropriate for the determination of the reliability level required by §25.1155(c) and for assessing the effects of any other failure conditions or malfunctions.

f) Reverser/pitch below flight regime availability on ground

Landing or Aborted take-off distances on wet runways usually take credit for the braking effect created by reverse thrust or propeller pitch below flight idle. Therefore availability of these systems when in the approved operating envelope must be maintained.
It must therefore be shown that failures in the system provided to meet §25.1155(b) do not degrade significantly the availability of the reverse thrust or low pitch selection on ground.

7. INSTRUCTIONS FOR CONTINUED AIRWORTHINESS

7.a. Manufacturing/Quality: Due to the criticality of the reverse thrust function or pitch below flight regime function, manufacturing and quality assurance processes should be assessed and implemented, as appropriate, to ensure the design integrity of the critical components.

7.b. Maintenance and Alterations: reference to § 25.901(b)(2) and § 25.1529/Appendix H. The criticality of the control system requires that maintenance and maintainability be emphasized in the design process and derivation of the maintenance control program, as well as subsequent field maintenance, repairs, or alterations.

7.c. Manuals- Limitations/Procedures:
Prohibition of use of reverse thrust or pitch settings below the flight regime when outside the approved in-flight operating envelope for that function should be introduced in AFM.
Cautions as described in 1155(d) and (e) and their related procedures should be included in the Operations Manual.

From: Hamer, Michael[SMTP:HAMERM@tc.gc.ca]
Sent: Monday, May 15, 2000 2:56 PM
To: 'Lewis-Smith, Frederick A'
Cc: Cousineau, Yves
Subject: RE: Fast track reports for 25.1155 and 25.1193

We agree with the 25.1193 report. For the 25.1155 report we agree with the
change for thrust reverser applications; however for certain turbo prop
applications the extra means (with it's susceptibility for failur e) to
prevent intentionally going below the flight regime, is not requir ed since
excessive force would be needed - e.g., Turbo Caribou aircraft.

Mike Hamer

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FAA Action – Not Available